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For: Method and Arrangement in the On-Line Finishing of the Paper Machine

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TITLE OF THE INVENTION

Method and Arrangement in the On~~-~~-Line Finishing of the Paper Machine ~~-~~

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CROSS REFERENCES TO RELATED APPLICATIONS

[0001] This application is a U.S. national stage application of International App. No. PCT/FI2003/000810, filed Nov. 3, 2003, the disclosure of which is incorporated by reference herein, and which claims priority on Finnish App. No. 20025048, filed Nov. 4, 2002.

STATEMENT AS TO RIGHTS TO INVENTIONS MADE UNDER FEDERALLY SPONSORED RESEARCH AND DEVELOPMENT

[0002] Not applicable.

BACKGROUND OF THE INVENTION

[0003] The invention relates to a method in the on-line finishing of ~~[the]~~a paper machine, which includes at least the successive finishing stages of precalendering and coating for the paper web produced in the paper machine prior to reeling, in which method a tail is formed from the paper web and this tail is taken through the finishing stages in such a way that after the tail threading procedure of the finishing stage the tail is spread to form a fully wide paper web prior to forming and taking a following tail to the following finishing stage. The invention also relates to an arrangement in the on-line finishing of the paper machine.

[0004] Today in~~[the]~~ paper machines, the tendency is to locate the finishing line immediately after the production line in order to improve efficiency. This means that the paper web is immediately guided to the finishing process from the last section of the production line without intermediate reeling and a separately located finishing line. In other words, the paper web runs at the production speed during finishing, and therefore the term on-line finishing is also used. Normally finishing includes coating of the paper. To produce an optimum quality paper, the paper web is first precalendered in the finishing process in order to ensure successful coating. Finally the coated paper is often also calendered, which provides a good surface smoothness and gloss, for example, to the coated paper.

[0005] The paper web is taken through the various finishing stages by means of a tail formed out of the paper web. The tail also proceeds at the production speed. Consequently, particularly the speed differences between the various tail threading devices often cause a tail threading failure. In addition, the paper web is spread to the full width between the different finishing stages prior to starting the following tail threading procedure. In present applications the tail must be taken, for example, through the coating process and spread to the full width before the paper web can be measured in respect of precalendering. Consequently, controlling of the various finishing stages is indefinite and awkward because the reliability of the effect of the various finishing stages is uncertain. Furthermore, in the situation described above,

the coated paper needs to be guided to broke treatment during the precalendering adjustment. This increases the consumption of the coating material and complicates the broke treatment.

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5 ~~]~~[0006] Adjustment problems are also created in tail threading because the tail needs to be guided for a long distance. This makes the tail stretch and even break sometimes. Also the speed differences between the various tail threading devices and finishing devices lead to tail breaking, in which case the tail threading procedure must be usually started over again. Particularly in the present paper machines the tail 10 threading devices are provided with speed sensors. In practice, however, controlling the speed of the tail threading devices and a sufficiently accurate speed measurement are difficult and sometimes even impossible. With the further increasing speed, the problems become even worse. Normally the tail is transferred through the finishing stage by means of ropes. The finishing stage often ends at a drying unit, which 15 comprises dryer cylinders and a dryer wire. When arriving at the drying unit with the carrier rope system, the tail tends to move onto the dryer wire if even a slight speed difference is present. In this situation the tail normally breaks and tail threading fails. At the same time, parts of the tail remain in the drying unit, which may disturb the following tail threading attempts.

20 [0007] The tail is usually formed out of the paper web using water cutters, which are arranged in connection with the drying units. As the paper web must be cut against the dryer wire, cuttings gradually block the dryer wire. Cuttings also spread into the drying unit and, in the worst case, to the entire finishing process following it. This increases the likelihood of web breaks and impairs the quality of the final 25 product. Furthermore, various kinds of cleaning devices are required.

[0008] US ~~[patent]~~Pat. No. ~~[4728396]~~4,728,396 sets forth a coater and a method for using it. In this method the web is guided to the broke pit at the full web width after unreeling the paper reel. A tail is separated from the web, and this tail is guided

to the coating device. After spreading the tail, coating is started. At a web break, the web is led to the broke pit at the processing speed and the tail threading procedure is repeated. The equipment in question is a so-called off-machine coater. In addition, there is low potential in contributing to a successful tail threading.

SUMMARY OF THE INVENTION

[0009] The object of the invention is to provide a novel method for the on-line finishing in the paper machine, which is more reliable than heretofore and minimizes production breaks. Another object of the invention is to provide a novel arrangement for the on-line finishing in the paper machine, which avoids both tail breaks and unnecessary soiling of the finishing processes. ~~[The characteristics of the method according to this invention become evident from the appended claim 1. Correspondingly, the characteristics of the arrangement according to the invention become evident from the appended claim 7.]~~ In the method according to the invention, each finishing stage is used independently. This enables an optimum control of each finishing stage minimizing the production breaks. Correspondingly, the final result of each finishing stage can be determined prior to moving to the following finishing stage. This facilitates the control of the paper machine and reduces the amount of broke. In addition, with the arrangement according to the invention, the tail can be kept under ~~[a]~~better control than heretofore. At the same time, the likelihood of a successful tail threading is higher than before. In addition, the arrangement according to the invention is grouped better than earlier and its discontinuation points are as few as possible. The arrangement also allows ~~[to cut]~~cutting the paper web without soiling the finishing stage. At the same time, broke treatment can be easily arranged at the end of the finishing stage.

[0010] The invention is described below in detail by making reference to the enclosed drawings, which illustrate some of the embodiments of the invention~~[, in which]~~.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] Figure 1 shows a skeleton drawing of the arrangement according to the invention.

[0012] Figure 2a shows a variation of one finishing stage of the arrangement illustrated in Figure 1.

[0013] Figure 2B shows another variation of one finishing stage of the arrangement illustrated in Figure 1.

[0014] Figure 3 is an enlarged view of a part of the whole of the arrangement according to the invention.

[0015] Figure 4a is a flow chart, covering one finishing stage, illustrating the operation of the arrangement according to the invention.

[0016] Figure 4b is a skeleton drawing illustrating the travel of the paper web in one finishing stage of the arrangement according to the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0017] Figure 1 is a skeleton drawing of the arrangement according to the invention, which is specifically intended for ~~[the]~~on-line finishing in ~~[the]~~a paper machine. In ~~[Figure]~~FIG. 1 the actual production stages of the paper machine end at the dryer section 10, from which the paper web produced with the paper machine is run down to broke treatment. Similar points, at which the paper web is run down, are illustrated in the drawings with downward pointing arrows. Broke treatment equipment is not shown in the drawings. At the end of the finishing process, the paper web is reeled up with the reel 11. Prior to reeling the finishing process includes the successive finishing stages of at least precalendering 12 and coating 13. Here coating 13 is additionally followed by calendering 14. The finishing stages 12~~[~~-~~]~~-14 also include the tail threading equipment 15 for taking the tail through the finishing stages 12~~[~~-~~]~~-14. To form the tail out of the fully wide paper web, the tail threading equipment 15 also includes cutting equipment 16. Here the tail threading equipment 15 mainly consists of carrier rope systems 17, which are used to carry the tail onwards. The tail threading equipment 15 also comprises, mainly between the various finishing stages, vacuum belt conveyors 18, which are used to transfer the tail, formed out of the paper to be run down, to the tail threading equipment of the following finishing stage – in this case to a carrier rope system. For clarity, neither the paper web nor the tail is shown in figures. In each finishing stage the carrier rope systems essentially pass over the same route as the paper web does in the production.

[0018] In the application displayed precalendering 12 consists of two successive so-called soft calenders 19. Their calendering nips are composed of a hard roll 20 and a softer counter roll 21. In the successive soft calenders 19 the softer counter roll 21 is alternately on the different sides of the paper web, thus precalendering the two sides of the paper web in turn. Prior to the soft calenders 19, on both sides, there is additionally moistening equipment 22, which can be used to adjust the moisture profile of the paper web when required. Coating also takes place in the nip, which is followed by the drying equipment 30. Finally, there is a so-called hard calender 23, composed of several rolls placed on top of each other between which several nips

are formed. From the hard calender 23 the coated and calendered paper web is led to the reel 11, which shares a carrier rope system with the hard calender 23. The equipment used in various finishing stages can vary between different applications. The same reference numbers are used for functionally similar parts.

[0019] According to the invention, at the end of each finishing stage there is a draw point forming one contact for tensioning and holding the paper web in the finishing stage concerned. The draw point is generally referred to with the number 24. Due to the draw point, the paper web is kept under control for the entire duration of the finishing stage. A single contact of the draw point is particularly important as regards the tail. In practice, the draw point terminates the finishing stage and the carrier rope system used as the tail threading device is guided through it. Due to the single contact, the speed difference between the tail threading device and the draw point, as well as a possible tail break caused by it, have no importance, because the tail is run down to broke treatment immediately after the draw point. In other words, it may be even desirable that the tail is transferred to the draw point from the tail threading device, the tail thus being immediately under control. Consequently, also the paper web can be spread earlier than before, which shortens the production break.

[0020] The arrangement preferably also includes measuring elements 25 arranged in the finishing stage 12~~[-]~~14 prior to the draw point 24 for determining the desired properties of the paper web. The purpose of the measuring elements is discussed in more detail in connection with the description of the method according to the invention.

~~[Figure]~~[0021] FIG. 1 shows an arrangement according to the invention, in which both the draw point 24 placed after precalendering 12 and the one after coating 13 are similar. ~~[Figures]~~FIGS. 2a and 2b show variations of the draw point after precalendering. The point in question is circled with a dot-and-dash line in ~~[Figure]~~FIG. 1. Generally the draw point forming a single contact is arranged as a

roll nip or a fabric transfer between two rolls. In ~~[Figure]~~FIG. 2a one roll in the roll nip is a counter roll 21 adapted for precalendering 12, while the other one is a separate auxiliary roll 26. This ensures that the total length of the finishing stage remains as short as possible. On the other hand, an extra auxiliary roll complicates the design of the precalender and hinders its guiding especially in tail threading. ~~[Figure]~~FIG. 2b illustrates a third application of the draw point 24, in which both the rolls of the roll nip are auxiliary rolls 27. The auxiliary rolls 27 are additionally arranged separately from the equipment included in the finishing stage. In this case, precalendering remains unchanged, but an extra pair of rolls increases the length of the finishing stage. In both the applications set forth above the problem is additionally the distance between the cutting equipment and the following finishing stage, i.e. coating here. Furthermore, drying of the paper web is impossible. On the other hand, in the application of ~~[Figure]~~FIG. 2b the cutting equipment 16 could also be located within the open draw of the paper web.

[0022] Both of these problems are avoided with the draw points 24 illustrated in ~~[Figures]~~FIGS. 1 and 3, in which the fabric transfer is formed between one dryer cylinder 28 and a dryer wire 29 arranged to contact it. In this way, a drying effect is provided to the paper web at the draw point and the paper web can be simultaneously drawn more efficiently than before. The tail is also reliably transferred to the influence area of the dryer wire so that the tail can be quickly taken under control before it is run down to broke treatment. In this application, too, the speed difference between the dryer wire and the carrier rope system has no significance, yet, in practice, it is attempted to keep it as small as possible. The solution also provides an advantageous tail formation. The only drawback is mainly the increased length of the finishing stage. On the other hand, a single-cylinder draw point is remarkably shorter than the known three-cylinder drying equipment. Furthermore, in the embodiment set forth, the paper web can be dried also after precalendering.

~~[Figure]~~[0023] FIG. 3 is a more detailed illustration of the single-cylinder

application. Even a small wrap angle of the dryer wire 29 provides a reliable tail seizure and an efficient paper web draw. According to the invention the cutting equipment 16 is adapted to cut the tail from the paper web within its open draw. This becomes evident specifically in ~~[Figure]~~**FIG.** 3. Here the cutting equipment 16 is composed of water cutters, which are arranged prior to the actual draw point. This prevents access of cuttings to the production process or onto the dryer wire, and it is easy to guide away the cuttings from the cutting point in a controlled way. In addition, the cutting equipment is placed advantageously near to the run-down position, which minimizes disturbances in tail threading and spreading of cuttings to the process.

[0024] Normally the paper web is spread to the full width after tail threading prior to forming and taking the following tail to the following finishing stage. According to the invention, prior to starting the tail threading procedure of the next finishing stage and forming the tail, the finishing stage in question is surprisingly set to the production settings while the paper web is spread in its full width. This facilitates the total control of the finishing stages. A reliable broke treatment is provided with the above described draw point, which is used to tension and hold the paper web in the finishing stage. This also ensures that the tension of the paper web is always appropriate particularly when using a single-cylinder draw point.

[0025] Draw points placed at the ends of the finishing stages also enable the determination of the paper web properties in each finishing stage already prior to starting the next tail threading. These properties are determined at the draw point and/or prior to it. To achieve this, the arrangement includes measuring elements 25 known as such, which are used to determine for example the moisture content of the paper web as well as porosity, gloss and other surface properties. **A controller 8 is arranged in data receiving relation to the measuring elements 25 forming part of the precalendering finishing stage 12, and the controller 8 is in controlling relation to the precalender 19. Similarly a controller 9 is arranged in data receiving relation to the measuring elements 25 forming part of the coating**

finishing stage 13. The controller 9 is in controlling relation to the coater 7. Based on the specified paper properties each finishing stage is then easy to adjust to the production settings. In this way, considering the whole, the control of the finishing stages is less complicated with a smaller broke amount and coating material consumption than heretofore.

[0026] Adjustments of the finishing stages particularly influence the properties of the paper web and the final product made of it. Furthermore, according to the invention, the properties of the tail in the tail formation are changed. This ensures a successful tail threading. In practice, the moisture content of the tail is changed using for example special moistening nozzles.

~~[Figure]~~**[0027] FIG.** 4a shows a flow chart in which the operation of the arrangement according to the invention is illustrated for one finishing stage, simplified for one stage. The stage starts with the reception of the tail formed in the previous stage. The tail threading procedure is repeated until it is successful, after which the paper web is spread to the full width. The tail transferred through the stage is run down to broke treatment at the end of the stage. According to the invention, the stage is thus set to the production settings after spreading and the treated paper web is measured. The determination of the quality of the paper web takes place based on these measurements. In case there are deviations in the quality, the stage will be adjusted. Once the desired paper web quality is achieved, a tail is formed and guided to the following stage.

~~[Figure]~~**[0028] FIG.** 4b shows the travel of the paper web in a stage, which is here coating 13. The use of the measuring elements 25 is possible at the draw point 24 according to the invention, which keeps the paper web under control at all times. Here the paper web has passed the stage and has already been spread to the full width. In practice, this spreading takes place in the previous stage. In the situation illustrated in ~~[Figure]~~**FIG.** 4b, the cutting equipment 16 is used to form a tail from the paper web whose quality has been proven good. The rest of the paper web is then

run down to broke treatment after the draw point 24. Between the stages the tail is transferred using for example the vacuum belt conveyors 18.

[0029] In the arrangement according to the invention, the various tail threading procedures are separate and distinct entities, corresponding to the different finishing stages. Each tail threading procedure includes few disturbance points and the tail is kept under control at all times. Due to the draw point according to the invention, the speed difference between the various tail threading devices and the draw point has no importance. Due to the draw point, the properties of the paper web can be determined in each finishing stage prior to the following finishing stage. In this way, using the method according to the invention, the production process can be appropriately adjusted in a simple and accurate manner. This saves both time and energy. At the same time, the finishing stage is kept clean, which reduces the need for cleaning equipment. With the method and arrangement according to the invention it is possible to optimize each finishing stage and hence also the paper properties prior to starting the following tail threading. In practice, precalendering and coating can be optimized prior to the start of the actual calendering, which also makes the entire finishing process remarkably more stable than heretofore.